FOR/FES-599

3-PG FOREST GROWTH MODEL

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Lecture 6

Exotic Plantations: Promises & Perils

Questions About Exotic Plantations

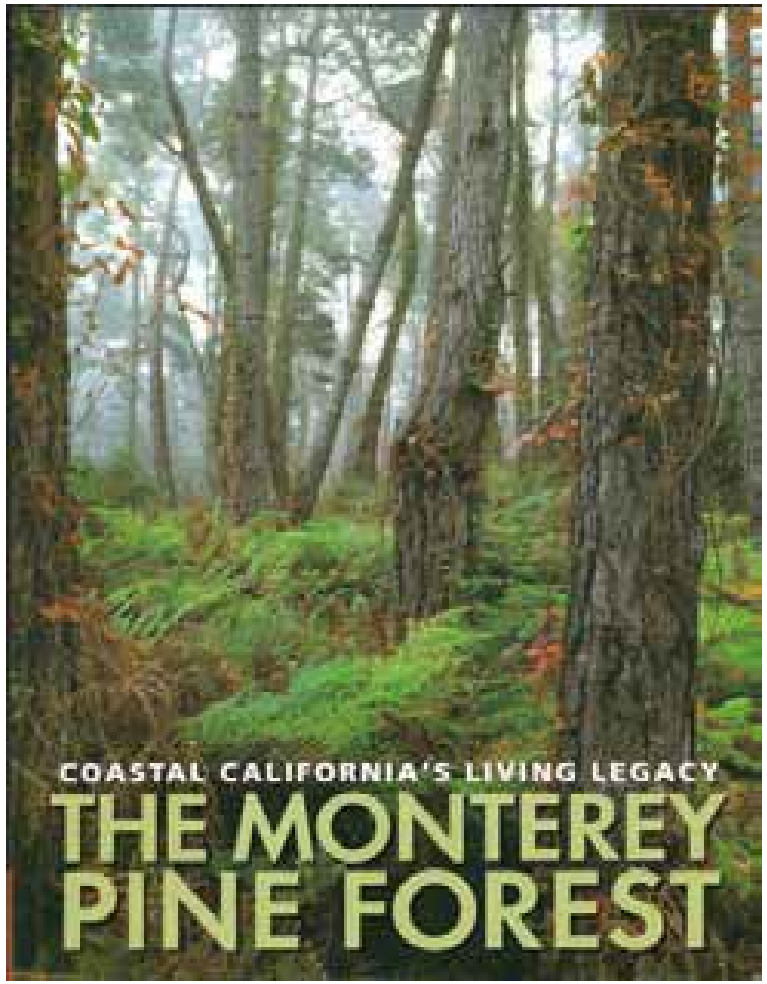
I. Why do exotic trees often grow better outside their native range than within?

II. What ecological benefits do exotic plantations contribute?

III. What detrimental attributes are associated with fast-growing exotic plantations?

Planted Species

The most widely planted pine species has a very limited natural range

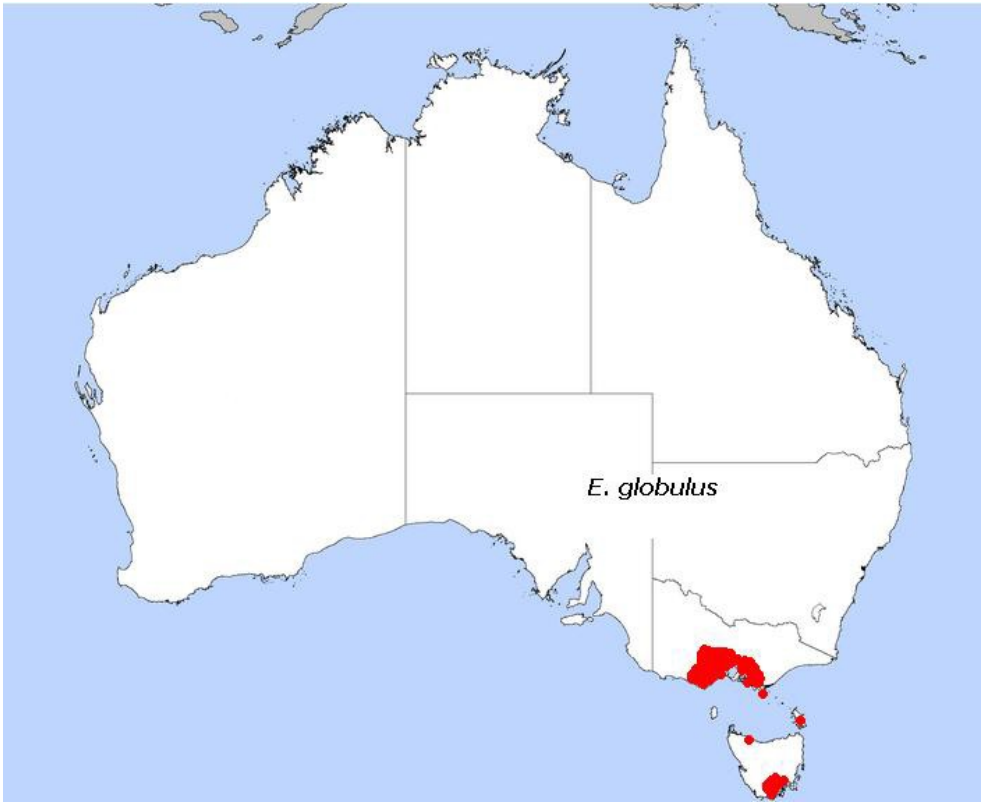


Pinus radiata

Monterey Pine (*Pinus radiata*) plantation in Chile, MAI = 30 m^3/ha/yr

Eucalyptus globulus

Blue gum (*Eucalyptus globulus*) has a limited natural range but is the most widely planted hardwood



Pacific Northwest Tree Species

Many Pacific Northwest tree species
grow as well or better outside their native ranges

Native range of Sitka Spruce. Photo by Alexander Karnstedt.

Waring, R.H. and J.F. Franklin. 1979. Evergreen coniferous forests of the Pacific Northwest. Science 204:1380-1386.

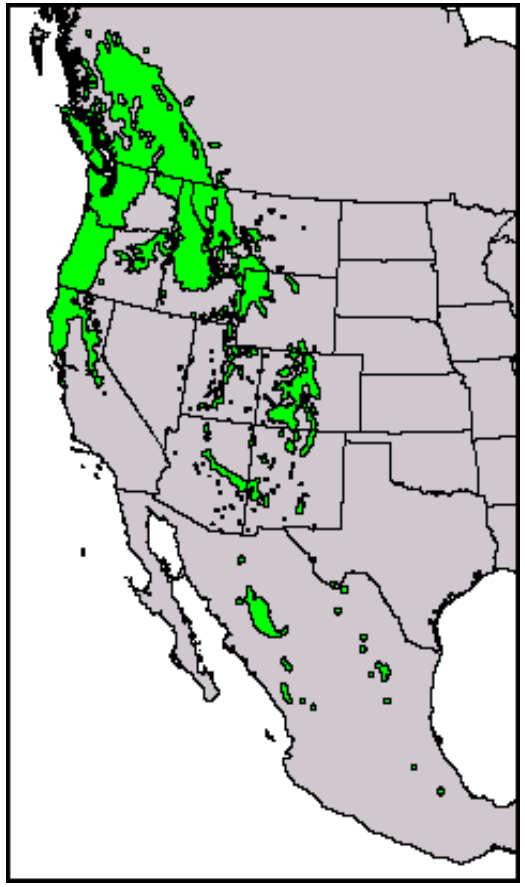
Picea sitchensis

Sitka spruce (*Picea sitchensis*) in Great Britain current annual increment > 40 m3/ha/yr

Waring, R.H. 2000. A process model analysis of environmental limitations on growth of Sitka spruce plantations in Great Britain. Forestry 73: 65-79.

Pseudotsuga menziesii

Douglas-fir (*Pseudotsuga menziesii*), the most widely distributed tree species in western N. America, grows better in New Zealand than in Oregon



Waring et al. 2008. Why is the productivity of Douglas-fir higher in New Zealand than in the Pacific Northwest, USA? For. Ecol. & Mgmt. 255:4040-4046.

Pinus contorta

Lodgepole pine (*Pinus contortal*) in Sweden

Pinus ponderosa

Ponderosa pine (*Pinus ponderosa*) plantations in Argentina grow 30 m3/ha/yr by having access to water at depths beyond that of roots of the native species

Ambient Temperature

Sometimes the native flora is not as well adapted to ambient temperatures as introduced species

Table 6.2. Optimum Temperature for Photosynthesis Compared with Actual Mid-summer Temperatures for Five Genera of Native New Zealand and North American Tree Species. From Hawkins and Sweet, 1989

Species	Optimum Temperature, °C	Mid-Summer Temperature, °C	Difference, °C
New Zealand			
Agathis australis	27.0	22.2	4.8
Dacrycarpus dacrydiodes	27.0	17.9	9.1
Dacrydium cupressinum	27.0	16.8	10.2
Nothofagus solandri	27.0	17.0	10.0
Podocarpus totara	27.0	21.5	5.5
Mean	27.0	19.1	+7.9
North America			
Larix decudua	17.0	19.0	−2.0
Pinus radiata	23.0	21.0	2.0
Pseudotsuga menziesii	21.0	20.2	0.8
Sequoia sempervirens	19.0	17.0	2.0
Tsuga heterophylla	18.0	20.2	−2.2
Mean	19.6	19.4	+0.2

Root Membrane Permeability

Root membrane permeability differs among species, affecting when leaves expand

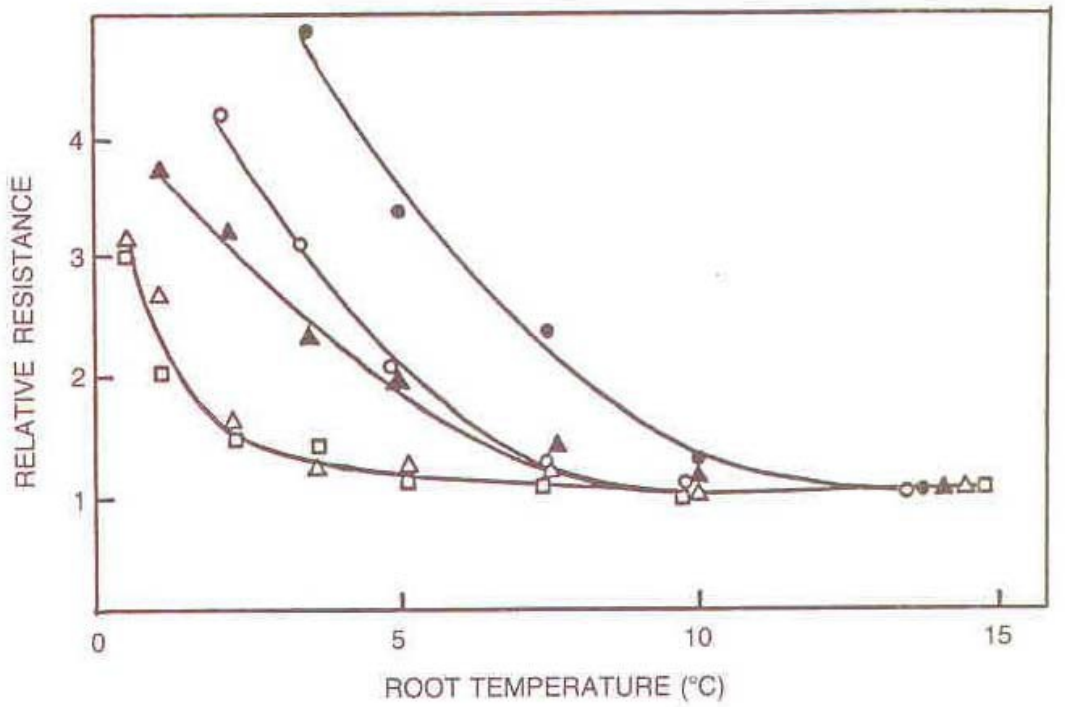


Figure 6.3. Five species of Northwest conifers—*Abies amabilis* (□), *A. procera* (△), *Thuja plicata* (▲), *Tsuga heterophylla* (○), and *Pseudotsuga menziesii* (■)—show differences in their relative resistance to water uptake when root temperatures are only below 10°C.

Sylviculture

Native ponderosa pine plantations in California are rarely intensively managed

Sylviculture

Eucalyptus plantations in Brazil receive more intensive silviculture than in Australia where the species is native

http://www.warnell.uga.edu/news/index.php/2009/03/impact-of-site-resources-on-the-productivity-of-eucalyptus-plantations-in-tropical-areas/2009uga_stape/

Sylviculture

In Brazil, growth is maximized through genetic selection of clones (1/3th), + weeding (1/3th), + fertilization (1/3th)

World-wide, plantations in 2000 occupied 2.8% of forested lands and produced 27% of total wood products (FAO 2006 Plantations: The Good, the bad, and the ugly).

Exotic Plantations

Explanation for rapid growth

- Weedy behavior makes trees highly responsive to light & nutrient availability
- Exotic species are often better adapted, physiologically and structurally, to climatic conditions where introduced than the native flora
- Exotic species (temporarily) leave behind their pathogens, insect and other animal pests
- Exotic species generally receive more intensive silviculture than native species with lesser commercial value

Exotic Plantations

- When exotic plantations replace degraded pastureland , they increase soil carbon content to that of native forests
  http://www.scielo.br/scielo.php?pid=S0100-06832009000600008&script=sci_arttext
- High yields by plantations reduce demands on native forests. As a result, there is now full protection of the remaining native woodlands in NZ.

- Plantations can stabilize slopes, protect watershed, and provide biological corridors for migratory species

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Native Eucalyptus

Native eucalyptus in western Australia kept water table from rising to the surface and forming salt pans

Native Eucalyptus

Eucalypt plantations in Western Australia quickly lower saline water table, and then dieback to an equilibrium LAI

http://link.springer.com/article/10.1007%2Fs11104-006-9032-4?LI=true

Benefits of Exotic Plantations

- Reclaim abandoned agricultural land
- Increase or maintain carbon stores in soil
- Reduce pressure on native forests
- Lower saline water table
- Protect watersheds
- Provide corridors for protection and migration of native species

Inconvenient of Exotic Plantations

Exotic plantations use ~ 50% more water when they replace grass and shrub covered lands, lowering the water table causing streams to run dry in the summer

Dye et al. 2004. Verification of 3-PG growth and water-use prediction in twelve *Eucalyptus* plantation stands in Zululand, South Africa. *For. Ecol.& Mgmt.***193**:197-218.

Inconvenient of Exotic Plantations

Exotic trees can spread into native forests

Removing western hemlock from native Scottish forest

Fire in an Eucalyptus Plantation

Fire in a eucalyptus plantation killed 25 people and injured 150 others.

The 1,520 acres (6.2 km²) destroyed 3,354 single-family dwellings and 437 apartments valued at $1.5 billion.

Berkeley California, October 1991

Exotic Tree Plantations

affect farming positively or negatively?

Forest plantation cooperative in Ghana share profits from forest and agriculture

Detrimental Attributes of Plantations

(Native or Exotic)

- Reduce biodiversity compared with natural forests
- Plantations may create fire hazards and may use more water than native vegetation.
- Large ownerships in plantations generally favor replacement of small land owners with corporate farms.
- Large additions of fertilizers required to maintain yields…not sustainable

Non-refereed Reference

2006. Forest Plantations: The Good, the Bad, and Ugly.
The IUCN/WWF Forest Conservation Newsletter Vol. 31.

http://www.fao.org/forestry/11509-0b7bb60246797272cd60dad25df4645c7.pdf